

CLAIMS

1. A support intended for observing between crossed polarisers an object placed on the support or in the vicinity thereof in a medium (3) of index  $n_0$  with

5 spatially incident convergent incoherent illumination under an angle  $\theta_0$  at a wavelength  $\lambda$ , including

- a substrate (1) of complex refraction index  $n_2$ ,
- a layer (2) of complex refraction index  $n_1$  and of thickness  $e_1$  characterised in that,

10 the value of the thickness  $e_1$  of the layer (2) is within 2 % so that:

$$\frac{d^2}{de_1^2} \ln|\sigma|^2 = 0$$

with

$$\sigma = \frac{\sigma_{01} + \sigma_{12}(1 + \pi_{01})e^{(-2j\beta_1)} + \sigma_{01}\pi_{12}e^{(-4j\beta_1)}}{(1 + r_{01(p)} + r_{12(p)}e^{(-2j\beta_1)})(1 + r_{01(s)}r_{12(s)}e^{(-2j\beta_1)})}$$

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a formula wherein  $\sigma_{ij}$  and  $\pi_{ij}$  represent respectively the sum and the product of the Fresnel coefficients of the different interfaces [(i,j)=(0,1) or (1,2)]:

$$r_{ij(p)} = \frac{n_j \cos \theta_i - n_i \cos \theta_j}{n_j \cos \theta_i + n_i \cos \theta_j}$$

and

$$r_{ij(s)} = \frac{n_i \cos \theta_i - n_j \cos \theta_j}{n_i \cos \theta_i + n_j \cos \theta_j}$$

and wherein  $\beta_1 = \frac{2\pi n_1 e_1 \cos \theta_1}{\lambda}$ ,

$$\text{with } \cos \theta_1 = \sqrt{1 - \left(\frac{n_0}{n_1}\right)^2 \sin^2 \theta_0}.$$

25 2. A support intended for observing between crossed polarisers an object placed on the support or in the vicinity thereof in a medium (3) of index  $n_0$  with incident convergent incoherent illumination under an angle  $\theta_0$  at a wavelength  $\lambda$ , including

- a substrate (1) of complex refraction index  $n_2$ ,

- a layer (2) of complex refraction index  $n_1$  and of thickness  $e_1$  characterised in that,

5 the value of the thickness  $e_1$  of the layer (2) is within 2 % so that:

$$\frac{d}{de_1} |\sigma^2| = 0$$

with

$$\sigma = \frac{\sigma_{01} + \sigma_{12}(1 + \pi_{01})e^{(-2j\beta_1)} + \sigma_{01}\pi_{12}e^{(-4j\beta_1)}}{(1 + r_{01(p)} + r_{12(p)}e^{(-2j\beta_1)})(1 + r_{01(s)}r_{12(s)}e^{(-2j\beta_1)})}$$

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a formula wherein  $\sigma_{ij}$  and  $\pi_{ij}$  represent respectively the sum and the product of the Fresnel coefficients of the different interfaces [(i,j)=(0,1) or (1,2)]:

$$r_{ij(p)} = \frac{n_j \cos \theta_i - n_i \cos \theta_j}{n_j \cos \theta_i + n_i \cos \theta_j}$$

15 and

$$r_{ij(s)} = \frac{n_i \cos \theta_i - n_j \cos \theta_j}{n_i \cos \theta_i + n_j \cos \theta_j}$$

and wherein  $\beta_1 = \frac{2\pi n_1 e_1 \cos \theta_1}{\lambda}$ , with  $\cos \theta_1 = \sqrt{1 - \left(\frac{n_0}{n_1}\right)^2 \sin^2 \theta_0}$ .

20 3. A support intended for optimising the useful extinction coefficient of a polarising microscope for observing an object placed on the support or above the support in a medium (3) of index  $n_0$  with incident convergent incoherent illumination under an angle  $\theta_0$  at a wavelength  $\lambda$ , including

- a substrate (1) of complex refraction index  $n_2$ ,
- a layer (2) of complex refraction index  $n_1$  and of thickness  $e_1$  characterised in that,

25 the value of the thickness  $e_1$  of the layer (2) is within 2 % so that:

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$$\frac{d}{de_1} \left( \frac{|\sigma|^2}{R_{NP}} \right) = 0$$

with

$$R_{NP} = \frac{1}{4} |r_p + r_s|^2 + \frac{1}{4} |r_p - r_s|^2$$

and

$$5 \quad r_p = \frac{r_{01(p)} + r_{12(p)} e^{(-2j\beta_1)}}{1 + r_{01(p)} r_{12(p)} e^{(-2j\beta_1)}} \quad \text{and} \quad r_s = \frac{r_{01(s)} + r_{12(s)} e^{(-2j\beta_1)}}{1 + r_{01(s)} r_{12(s)} e^{(-2j\beta_1)}}$$

and

$$\sigma = r_p + r_s = \frac{\sigma_{01} + \sigma_{12}(1 + \pi_{01}) e^{(-2j\beta_1)} + \sigma_{01}\pi_{12} e^{(-4j\beta_1)}}{(1 + r_{01(p)} + r_{12(p)} e^{(-2j\beta_1)})(1 + r_{01(s)} + r_{12(s)} e^{(-2j\beta_1)})}$$

10 a formula wherein  $\sigma_{ij}$  and  $\pi_{ij}$  represent respectively the sum and the product of the Fresnel coefficients of the different interfaces [(i,j)=(0,1) or (1,2)]:

$$r_{ij(p)} = \frac{n_j \cos \theta_i - n_i \cos \theta_j}{n_j \cos \theta_i + n_i \cos \theta_j}$$

and

$$r_{ij(s)} = \frac{n_i \cos \theta_i - n_j \cos \theta_j}{n_i \cos \theta_i + n_j \cos \theta_j}$$

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$$\text{and wherein } \beta_1 = \frac{2\pi n_1 e_1 \cos \theta_1}{\lambda}, \text{ with } \cos \theta_1 = \sqrt{1 - \left( \frac{n_0}{n_1} \right)^2 \sin^2 \theta_0}$$

20 4. A support according to claim 1 or 2 or 3, characterised in that the values of the refraction index  $n_1$  and of the thickness  $e_1$  of the layer (2) are within 2 % such that:

$$\sigma = 0$$

25 5. A support according to claim 4, characterised in that the substrate (1) and the layer (2) are dielectric or little absorbent, the module of the imaginary portion of their complex index being smaller than 0.01, the general conditions of the claim 4 being reduced to the conditions:

$$n_1 e_1 \cos \theta_1 = \frac{1}{4} + k \frac{1}{2}$$

and

$$n_1^2 = \frac{n_2^2 + \sqrt{n_2^2 \cos^2 \theta_0 (n_2^2 - n_0^2 \sin^2 \theta_0)}}{n_2^2 + n_0^2 \cos^2 \theta_0}$$

with  $k$  integer and with an uncertainty of 2 % on the values of  $n_1$  and  $e_1$ .

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6. A support according to claim 5, characterised in that  $\theta_0$  is smaller than  $5^\circ$ , the general conditions of the claim 4 being reduced to

$$\frac{2}{n_1^2} = \frac{1}{n_0^2} + \frac{1}{n_2^2}$$

10 and

$$n_1 e_1 \cos \theta_1 = \frac{1}{4} + k \frac{1}{2}$$

with  $k$  integer and with an uncertainty of 2 % on the values of  $n_1$  and  $e_1$ .

15 7. A support according to any of the claims 1 to 4 or 5 to 6, characterised in that it is intended for use with annular incident illumination with an angle of incidence  $\theta_0$  which is unique within  $\pm 2.5^\circ$ .

20 8. A support according to any of the claims 1 to 4 or 5 to 6, characterised in that it is intended for use in incident and convergent axial illumination with an average angle of incidence  $\theta_0$  associated with its total angular opening  $\Delta\theta_0$  by the relation :

$$\cos \theta_0 = \cos^2 \left( \frac{\Delta\theta_0}{2} \right)$$

25 9. A support according to any of the claims 1 to 8, characterised in that the illumination is monochromatic or quasi-monochromatic at the wavelength  $\lambda$ .

10. A support according to any of the claims 1 to 9, characterised in that the illumination has a continuous wide spectrum or is polychromatic with maximum span  $\pm 0.3 \lambda$  around its average wavelength  $\lambda$ .

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11. A support according to any of the claims 1 to 4 and 7 to 10, intended for use in the air as a surrounding medium (3), with  $\theta_0 = 30^\circ$  and  $\lambda = 589.3$  nm, characterised in that the substrate (1) is made of cadmium with  $n_2 = 1.13 - 5.01j$ , the layer (2) having an index  $n_1 = 1.42$  and  $e_1 = 1084$  Angströms.

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12. A support according to any of the claims 1 to 4 and 7 to 10, characterised in that the substrate (1) and the (2) have the specificities of the following table wherein  $n_1$  and  $e_1$  are the index and the thickness of the layer,  $n_2$  the complex refraction index of the substrate (1), in the air as a surrounding medium (3),

10  $\theta_0 = 5^\circ$  and  $\lambda = 540$  nm

Substrate	$n_2$	$n_1$	$e_1(\text{\AA})$
Gold	$0.40 - 2.6j$	1.70	694
Silver	$0.13 - 3.44j$	1.59	795
Aluminium	$0.92 - 0.95j$	2.01	348
Nickel	$1.76 - 3.2j$	1.51	847

13. A support according to any of the claims 1 to 4 and 7 to 10, characterised  
in that  $\theta_0$  is an average angle of incidence equal to  $20^\circ$  and in that the  
substrate (1) and the layer (2) have the specificities of the following table  
wherein  $n_1$  and  $e_1$  are the index and the thickness of the layer (2),  $n_2$  the  
complex refraction index of the substrate (1), in the air as a surrounding  
medium (3) and  $\lambda = 540$  nm.

Substrate	$n_2$	$n_1$	$e_1(\text{\AA})$
Gold	$0.40 - 2.6j$	1.64	739
Silver	$0.13 - 3.44j$	1.55	838
Aluminium	$0.92 - 0.95j$	1.89	399
Nickel	$1.76 - 3.2j$	1.48	890

20 14. A support according to any of the claims 1 to 4 and 7 to 10, characterised in that  $\theta_0$  is equal to  $5^\circ$  and in that the substrate (1) and the layer (2) have the specificities of the following table wherein  $n_1$  and  $e_1$  are the index and the thickness of the layer (2) within 2 %,  $n_2$  the complex refraction index of the

substrate (1),  $n_0$  the index of the surrounding medium (3) ,  $\lambda = 589,3$  nm when the layer (2) is made of cadmium and  $\lambda = 540$  nm in the other cases.

Substrate	$n_2$	$n_0$	$n_1$	$e_1$
Gold	$0.40 - 2.6j$	1.33	2.42	490
Gold	$0.40 - 2.6j$	1.5	1.79	755
Silver	$0.13 - 3.44j$	1.33	2.28	512
Silver	$0.13 - 3.44j$	1.5	2.7	412
Aluminium	$0.92 - 0.95j$	1	1.89	399
Nickel	$1.76 - 3.2j$	1.33	2.11	572
Nickel	$1.76 - 3.2j$	1.5	2.45	473
Cadmium	$1.13-5.01j$	1	1.49	970
Cadmium	$1.13-5.01j$	1.33	2.05	684
Cadmium	$1.13-5.01j$	1.5	2.36	582
Tin	$1.48-5.25j$	1	1.48	899
Tin	$1.48-5.25j$	1.33	2.02	640
Tin	$1.48-5.25j$	1.5	2.33	548
Copper	$1.04-2.59j$	1	1.62	746
Copper	$1.04-2.59j$	1.33	2.23	423
Copper	$1.04-2.59j$	1.5	2.83	351
Iron (evaporated)	$1.51-1.63j$	1	1.54	737
	$1.51-1.63j$	1.33	2.23	423
	$1.51-1.63j$	1.5	2.72	305

5 15. A support according to any of the claims 1 to 10, characterised in that the parameters defined by the claims 11 to 14 are kept with the exception of the wavelength  $\lambda$  and of the thickness  $e_1$  of the layer 2 which are modified proportionally,  $\frac{e_1}{\lambda}$  not being modified.

10 16. An accessory intended for observing a preferably liquid sample formed of a Petri dish and of a support intended for receiving said sample, characterised in that:

- the support complies with any of the claims 1 to 15,
- the support is the bottom of this dish.

17. A device for observing a sample including an optical microscope, a support intended for receiving said sample and two crossed polarisers, characterised in that the support complies with any of the claims 1 to 15.

5 18. A device for observing a sample including an optical microscope, an accessory intended for receiving said sample and two crossed polarisers, characterised in that the accessory complies with the claim 16.

10 19. A device for observing a sample including an optical microscope, a support intended for receiving said sample, a polariser and a quarter-wave blade, characterised in that the support complies with any of the claims 1 to 15.

15 20. A device for observing a sample including an optical microscope, an accessory intended for receiving said sample, a polariser and a quarter-wave blade, characterised in that the accessory complies with claim 16.

21. A device for observing a sample according to claim 16 or 17 or 18,  
20 characterised in that the optical microscope is fitted with a differential interferential contrast device.